Indiana
2007 Five-Percent Report

Prepared by

Andrew P. Tarko, Purdue University
Brad Steckler, Indiana Department of Transportation
Jorge Ramos, Purdue University
Darion Grant, Purdue University

Indiana Department of Transportation
Indianapolis, Indiana

Center for Road Safety
Purdue University
West Lafayette, Indiana

October 11, 2007

Contents

Introduction

The latest federal transportation act, SAFETEA-LU, created the Highway Safety Improvement Program (HSIP) as a new core federal aid funding. The purpose of the HSIP is to reduce traffic fatalities and serious injuries on public roads. As part of the new HSIP**,** States are required to submit an annual report describing not less than 5 percent of their highway locations exhibiting the most severe safety needs. The intent of this provision is to raise the public awareness of the highway safety needs and challenges in the States.

Vehicles on Indiana roads each year accumulate 74 billion miles of travel. There are nearly 96,300 miles of public roads in Indiana. State roads, U.S. highways, and interstates—those on the state (INDOT)-jurisdictional network—make up about 11,200 miles of that total, or roughly twelve percent.

Each year in Indiana 190,000 to 210,000 traffic crashes take place, distributed in this way by severity: 800 to 900 fatal crashes, 40,000 to 45,000 personal-injury crashes, and 150,000 to 160,000 property-damage crashes. The fatal crash events result in 900 to 950 persons killed annually. Personal-injury crash events result in injuries to 55,000 to 60,000 persons, of which about 3,500 persons are seriously injured (incapacitating). The personal, societal, and economic costs of this are staggering.

Factors contributing to traffic crashes and resulting losses are many, complex, and interrelated. A principal factor is driver behavior, including speeding, driving while impaired, aggressive driving, failure to use seatbelts, and operating a car or truck while drowsy or distracted. Other factors are vehicle condition (e.g., tire tread) and on-board safety features (e.g., anti-lock brakes), intensity of police enforcement, weather, and circumstances relating to emergency responders. As well, engineering status of the various elements of physical road infrastructure is a factor in crash risk, such as sharpness of curves, shoulder width, sight distance, and condition of traffic control devices.

Just as multiple factors contribute to road safety, the countermeasures available to improve operating conditions at select sites are numerous, often best employed from several aspects. These measures may include targeted police enforcement, (driver) education, or road engineering enhancement, among other practices.

Before adequate safety countermeasures can be applied, the road network must be screened to identify locations that need safety improvements. The presented 2007 Five–Percent Report provides a list of Indiana locations with safety needs. This report also presents the screening method and the accompanied implementation effort. Since the previous, 2006 Five-Percent Report, the following advancements have been made and incorporated in identifying 5% road location sites in Indiana this year:

- A Geographic Information System (GIS) map that includes all Indiana public roads has been used. This year, we have incorporated intersections and interchanges between state and local roads. This is an important step towards screening all the public roads in Indiana.

- Long road segments have been split into shorter sub-segments to be able identify short network components such as curves with safety needs.

- The ranking criteria of crash loss index and severe crash frequency/density address two important requirements: (1) statistical soundness and (2) consistency with the national safety management policy.

Identification Method

Road locations with severe safety needs are identified using a GIS transportation analysis package called TransCAD. Most of the steps leading to the identification of the 5% locations were facilitated through mapping features of TransCAD and developed in-house tools including network partitioning into shorter segments and crash assignment to locations.

Road Locations

A *road location* is a road intersection, an interchange, or a road segment.

A *road intersection* is a portion of roads within the intersection impact zone. For the purpose in this study of assigning crashes to particular locations, Indiana identifies the intersection impact zone as a circle around the intersection center with radius 250 ft. If the impact zones of adjacent intersections overlap then the midpoint between the intersections determines their impact zones boundaries.

A *road interchange* is a portion of roads within the interchange impact zone. The interchange impact zone is a circle around the interchange center with radius 500 ft. If the impact zones of adjacent interchanges and intersections overlap then the midpoint between them determines their impact zones boundaries.

A *road segment* is a road stretch between intersection/interchange impact zones. Long road segments are divided into smaller parts to allow more specific location with safety needs (such as curves). Rural segments longer than 0.5 mile are divided into sub-segments whose lengths are as close to 0.5 mile as possible. Urban road segments longer than 0.25 mile are divided into sub-segments whose lengths are as close to 0.25 mile as possible.

Evaluated in the 2007 Five-Percent Report are 39,345 intersections/interchanges and 29,840 road segments. Total number of sites evaluated is 69,185.

Crash Severity and Costs

Crashes are assigned to intersections, interchanges and road segments and counted over the three years 2004-2006. Crash severity is classified in four categories:

1. Property damage only crashes (PDOC),
2. Non-incapacitating injury crashes (NINC),
3. Incapacitating injury crashes (IINC), and
4. Fatal crashes (FTC).

The average cost of PDOC and NINC crashes is $7,500 while the average cost of one fatality is $1,150,000 and one incapacitating injury is $52,900 (source: National Safety

Council, 2005, http//www.nsc.org/lrs/statinfo/estcost.htm). The cost of a single crash is calculated as:

$$C = \$7{,}500 + \$52{,}900 \cdot IINP + \$1{,}150{,}000 \cdot FTP$$

where:
C = crash cost ($),
$IINP$ = incapacitating injuries (persons),
FTP = fatalities (persons).

The average cost of crash in a group of locations is the total crash loss divided by the number of crashes.

The average costs used in the 2007 Five-Percent Report are shown in Table 1.

Table 1 Average costs of crashes by group derived from Indiana 2004-2006 crash data (2005 dollars)

Location Type	Incapacitating Injury and Fatal Crash C_{IINFT} ($1000)	Injury and Fatal Crash C_{IF} ($1000)	PDO and Non-incapacitating Crash C_{PD} ($1000)
Rural segments	690	120	7.5
Urban segments	619	70	7.5
Rural intersection/interchange	448	67	7.5
Urban intersection/interchange	260	26	7.5

Safety Performance Measures

This year we are using two sequential safety performance measures:

1. *Crash loss index* (I). High crash loss index (higher than 3) indicates locations where the total crash loss is significantly higher than the loss typical for the exposure and the type of location. Use of this indicator increases the chance that identified locations are those with actual safety needs and not those experiencing a random flux of crashes. This measure also accounts for distribution in crash severity.

2. Number of fatal and incapacitating injury crashes (FTIINC) at intersections and density of these crashes (DEN_FTIINC in crashes per mile) on road segments are additional measures that further focus the road network screening on particularly severe crashes.

The first criterion makes the selection process statistically sound, while the second criterion implements the current national safety management goal of reducing the frequency of severe crashes.

The crash loss index (I) is the difference between the actual crash loss and the typical crash loss divided by the standard deviation of the difference.

$$I = \frac{L - \overline{L}}{\sqrt{\sigma_L^2 + \sigma_{\overline{L}}^2}}$$

$$L = C_{PD} \cdot PD + C_{IF} \cdot IF$$
$$\overline{L} = C_{PD} \cdot a_{PD} + C_{IF} \cdot a_{IF}$$
$$\sigma_L^2 = C_{PD}^2 \cdot PD + C_{IF}^2 \cdot IF$$
$$\sigma_{\overline{L}}^2 = C_{PD}^2 \cdot a_{PD}^2 \cdot D_{PD} + C_{IF}^2 \cdot a_{IF}^2 \cdot D_{IF}$$

where:
I = the crash loss index,
L = total crash loss during the analyzed period, in dollars,
$\overline{L}$ = expected crash loss during the analyzed period, in dollars,
σ_L^2 = variance of the crash loss,
$\sigma_{\overline{L}}^2$ = variance of the expected crash loss,
PD = number of property-damage-only crashes in analyzed period,
IF = number of injury and fatal crashes in analyzed period,
C_{PD} = average PD crash cost taken from Table 1, in dollars,
C_{IF} = average IF crash cost taken from Table 1, in dollars,
a_{PD} = typical PDO crash frequency calculated with the safety performance functions given in Appendix A, in crashes/analyzed period,
a_{IF} = typical IF crash frequency calculated with the safety performance functions given in Appendix A, in crashes/analyzed period,
D_{PD} = over-dispersion parameter for a_{PD} estimate taken from Tables A.2 and A.4,
D_{IF} = over-dispersion parameter for a_{IF} estimate taken from Tables A.1 and A.3.

Five-Percent Lists

The 2007 Five-Percent Report identifies road locations with the most severe safety needs through a two-step screening process applied to the 2004-2006 crash data:

1. Intersections, interchanges, and segments having a crash loss index (I) at or above 3.0 advance to step two.

2. Advancing to the final list are:

    a. Intersections and interchanges that have two or more fatal or incapacitating injury crashes (FTIINC),

    b. Segments that have a density of fatal and incapacitating injury crashes (DEN_FTIINC) at 11 crashes per mile or higher.

This two-step screening process has identified 110 locations with safety needs: 96 intersections/interchanges and 14 segments. The 110 locations make up 267 fatal and incapacitating injury crashes over the three-year period. Given that the total number of fatal and incapacitating injury crashes in the same period and at all locations in Indiana subject to analysis is 4,141, the identified 110 locations make up 6.4 percent of the total. Overall, these 110 locations are heavily over-represented in number of fatal and incapacitating injury crashes as they represent 0.17 percent of the analyzed statewide locations while experiencing 6.4 percent of fatal and serious injury crashes.

Locations of the final five-percent sites with safety needs are provided in the following intersection/interchange and segment lists.

Table 2 Intersections and interchanges in Indiana 2007 Five-Percent Report (sorted by county)

Location	City	County	No. Fatal Crashes (FTC)	No. Incapa-citating Injury Crashes (IINC)	No. Non-Incapa-citating Injury Crashes (NINC)	No. Property-Damage-Only Crashes (PDC)	No. Fatal and Injury Crashes (IFC)	No. Persons Killed (FTP)	No. Persons Seriously Injured (IINP)	Index of Crash Loss (I)	No. Fatal and Incapa-citating Injury Crashes (FTIINC)	No. Persons Killed or Seriously Injured (FTINP)	Inter-section ID (INT_ID)
SR 930 (Coliseum Blvd) at Crescent Av, 2.2 miles east of US 27	Fort Wayne	Allen	0	4	17	85	21	0	5	3.59	4	5	11116
SR 930 (Coliseum Blvd) at Coldwater Rd, 0.7 mile east of US 27	Fort Wayne	Allen	1	2	32	117	35	1	4	4.97	3	5	10664
SR 930 (Coliseum Blvd) at Goshen Rd, 0.4 mile southeast of I-69	Fort Wayne	Allen	0	2	13	68	15	0	3	4.54	2	3	10836
US 27 (Lafayette St) at Main St, 2.8 miles south of SR 930	Fort Wayne	Allen	0	2	18	63	20	0	4	4.26	2	4	13039
SR 930 (Coliseum Blvd) at Clinton St, 1.1 miles east of US 27	Fort Wayne	Allen	1	1	23	92	25	1	2	3.76	2	3	10674
US 31 at 10th St at Taylor Rd, 3.3 miles north of SR 46	Columbus	Bartholomew	1	1	16	44	18	1	1	3.76	2	2	21583
SR 18 at CR CR 400W/CR 1200E (Grant-Blackford county line), 5.5 miles east of I-69	NA	Blackford	0	2	6	15	8	0	2	3.19	2	2	27173
SR 62 at Decker Ln, 4.2 miles northeast of SR 3, near Charleston	NA	Clark	2	0	10	17	12	2	1	3.59	2	3	51386
SR 257 at old US 50 (National St) at Wolf St	Washington	Daviess	0	3	16	23	19	0	3	5.51	3	3	70664
SR 8 at Grandstaff Dr	Auburn	DeKalb	0	2	17	84	19	0	3	5.56	2	3	90994

Table 2 continues

McGallard Rd at Wheeling Av	Muncie	Delaware	0	2	24	125	26	0	2	6.35	2	2	94670
US 20 at CR 17 interchange	Elkhart	Elkhart	1	1	15	98	17	1	1	6.58	2	2	109099
SR 19 at Bristol St east junction at Cassopolis St	Elkhart	Elkhart	1	1	19	126	21	1	1	5.79	2	2	106984
SR 19 at CR 6 (Heaton Lake Rd)	Elkhart	Elkhart	0	2	19	105	21	0	3	5.27	2	3	105858
SR 15 at CR 38 (Kercher Rd)	Goshen	Elkhart	0	2	15	29	17	0	3	4.86	2	3	111635
US 33 at CR 28 (Peddlers Village Rd)	Goshen	Elkhart	1	1	13	82	15	1	1	4.4	2	2	110743
US 6 at CR 29, 1.0 mile west of SR 13	NA	Elkhart	1	1	9	19	11	1	2	3.57	2	3	112965
SR 1 at 24th St, 1.8 miles north of SR 44 north junction	Connersville	Fayette	0	2	14	26	16	0	3	4.15	2	3	114285
SR 111 (Vincennes St) at Spring St, 1.6 miles northeast of I-164	New Albany	Floyd	0	2	16	34	18	0	2	4.17	2	2	118218
SR 111 at Beechwood Av at Charleston Rd, 2.5 miles south of I-265	New Albany	Floyd	0	2	12	36	14	0	2	4.1	2	2	117764
SR 32 at US 31 and Elm St	Westfield	Hamilton	0	3	19	82	22	0	4	7.02	3	4	151901
US 421 (Michigan Rd) at 96th St	Indianapolis	Hamilton	0	2	18	65	20	0	2	5.59	2	2	161567
US 31 at Greyhound Pass	Westfield	Hamilton	0	2	27	108	29	0	2	5.44	2	2	150559
US 31 (Meridian St) at 116th St	Carmel	Hamilton	0	2	13	121	15	0	2	4.56	2	2	156973
SR 37 at 191st	Noblesville	Hamilton	0	2	8	22	10	0	2	3.03	2	2	150667

Table 2 continues

US 40 at CR 600E	NA	Hancock	1	3	17	35	21	1	3	5.12	4	4	160581
US 40 at CR 500E	NA	Hancock	1	1	19	32	21	1	1	5.02	2	2	161500
SR 267 at CR 300S, 1.0 mile north of US 40	NA	Hendricks	1	1	5	23	7	1	1	3.22	2	2	173176
SR 267 at Maplehurst Dr	Brownsburg	Hendricks	0	2	10	25	12	0	2	3.01	2	2	166876
SR 3 at CR 300N	NA	Henry	0	2	7	22	9	0	2	3.22	2	2	172264
SR 22 (Markland Av) at Apperson Way	Kokomo	Howard	0	2	16	29	18	0	3	4.89	2	3	179857
US 31 at Lincoln Rd	Kokomo	Howard	0	2	22	84	24	0	2	3.61	2	2	181367
US 50 at Community Dr, 3.2 miles west of I-65	Seymour	Jackson	0	2	10	22	12	0	3	3.38	2	3	188008
SR 62 (Clifty Dr) at Michigan Rd, 1.1 miles west of US 421	Madison	Jefferson	0	2	9	74	11	0	2	6.38	2	2	195430
SR 3 at Poplar St at Jackson St, 1.6 miles south of US 50	Vernon	Jennings	0	2	8	16	10	0	4	3.1	2	4	201846
US 31 at Stop 18 (CR 800N)	Greenwood	Johnson	0	2	24	47	26	0	4	4.12	2	4	206242
SR 44 at Hospital Rd at Centerline Rd, 1.2 miles southwest of SR 144, near Franklin	NA	Johnson	0	2	7	12	9	0	2	3.14	2	2	207752
US 31 at SR 252, 2.6 miles west of I-65	Edinburgh	Johnson	1	1	12	45	14	1	1	3.02	2	2	208902
US 20 at CR 600W south junction, 3.1 miles east of SR 5	NA	Lagrange	0	2	4	24	6	0	2	3	2	2	225200

Table 2 continues

SR 55 at 45th Av	NA	Lake	0	3	15	35	18	0	3	4.34	3	3	235233
US 30 at Randolph St	Hobart	Lake	0	3	12	59	15	0	4	3.43	3	4	239059
US 30 at Rhode Island St	Merrillville	Lake	1	2	20	138	23	1	2	3.37	3	3	238365
SR 312 at Hohman Av	Hammond	Lake	0	2	14	53	16	0	2	5.4	2	2	228185
US 41 at Ridge Rd	Highland	Lake	0	2	22	89	24	0	2	4.92	2	2	235419
US 41 at 45th	Highland	Lake	0	2	25	90	27	0	2	4.52	2	2	236556
SR 312 (Chicago Av) at Railroad Av	East Chicago	Lake	0	2	16	21	18	0	2	4.42	2	2	228537
US 30 at Mississippi St	Merrillville	Lake	0	2	33	148	35	0	3	4.4	2	3	239356
SR 53 at 109th Av	Crown Point	Lake	1	1	11	33	13	1	1	4.34	2	2	240691
US 30 at Merrillville Rd	Merrillville	Lake	0	2	28	130	30	0	2	4.04	2	2	238368
US 231 at Iowa St, 1.3 miles southeast of I-65	NA	Lake	1	1	11	17	13	1	1	3.69	2	2	242679
US 30 at Colorado St	Hobart	Lake	0	2	33	88	35	0	2	3.61	2	2	238731
US 421 at Kieffer Rd (CR 400N)	Michigan City	LaPorte	0	3	8	54	11	0	3	3.41	3	3	247277
US 421 at SR 2 south junction at CR 400S	Westville	LaPorte	0	2	13	37	15	0	2	4.06	2	2	253223
SR 2 at Fail Rd (CR 100E), 2.6 miles northeast of US 35	LaPorte	LaPorte	2	0	8	21	10	2	1	3.42	2	3	249218

Table 2 continues

SR 9 at 5th St	Anderson	Madison	1	2	16	55	19	1	2	3.19	3	3	260789
SR 135 at Southport Rd	Indianapolis	Marion	1	6	16	45	23	1	7	3.44	7	8	296638
US 31 at Thompson Rd	Indianapolis	Marion	0	5	30	80	35	0	5	3.55	5	5	296806
US 36 (Pendleton Pike) at Franklin Rd, 0.5 mile northeast of I-465 East Leg	Indianapolis	Marion	1	2	28	68	31	2	5	3.78	3	7	274653
US 40 at Raceway Rd	Indianapolis	Marion	0	2	40	91	42	0	2	7.09	2	2	174154
US 36 (Pendleton Pike) at Post Rd, 1.6 miles east of I-465 East Leg	Indianapolis	Marion	0	2	29	58	31	0	3	4.53	2	3	274966
US 36 (Rockville Rd) at Girls School Rd	Indianapolis	Marion	0	2	28	172	30	0	2	4.52	2	2	291100
SR 135 at Johnson-Marion County Line Rd	Indianapolis, Greenwood	Marion	1	1	19	64	21	1	1	3.69	2	2	204269
US 52 at Post Rd	Indianapolis	Marion	1	1	11	31	13	1	1	3.33	2	2	290158
US 36 at High School Rd	Indianapolis	Marion	0	2	31	104	33	0	2	3.05	2	2	289727
US 30 at Oak Road, 3.1 miles west of US 31	Plymouth	Marshall	1	1	15	42	17	1	1	4.3	2	2	301405
SR 37 at Dillman Rd, 4.2 miles south of SR 45 west junction	NA	Monroe	1	2	14	13	17	1	2	3.59	3	3	319704
SR 37 at Vernal Pike	Bloomington	Monroe	0	2	32	56	34	0	2	5.57	2	2	311409
SR 45 at Curry Pike/Leonard Springs Rd	Bloomington	Monroe	0	2	15	36	17	0	4	3.72	2	4	315343

Table 2 continues

SR 37 at Smithville Rd, 5.9 miles south of SR 45 west junction	NA	Monroe	0	2	14	6	16	0	4	3.21	2	4	318075
US 231 at 0.1 mile north of CR 575N	NA	Montgomery	1	1	7	25	9	1	1	3.45	2	2	320267
SR 32 at SR 47/Englewood Dr	Crawfordsville	Montgomery	0	2	12	26	14	0	2	3.28	2	2	318866
SR 144 at Kitchen Rd, 3.1 miles east of SR 67	NA	Morgan	1	1	8	19	10	1	2	3.43	2	3	333134
SR 67 at Bridge St	Mooresville	Morgan	0	2	14	46	16	0	2	3.39	2	2	331813
SR 42 at Keller Hill Rd (CR 1200N) at Bethel Rd	Mooresville	Morgan	0	2	8	7	10	0	3	3.34	2	3	331507
US 6 at Calumet Av (CR 150E), 0.5 mile east of SR 49	NA	Porter	1	6	21	53	28	1	8	3.28	7	9	393585
US 20 at Wagner Rd, 1.1 miles west of SR 49	Porter	Porter	3	1	12	30	16	3	2	4.38	4	5	394428
SR 49 at CR 600S, 2.0 miles north of SR 8	NA	Porter	0	4	8	9	12	0	5	3.42	4	5	397826
US 20 at Waverly Rd, 0.5 mile west of SR 49	Porter	Porter	0	2	20	20	22	0	3	4.55	2	3	392587
SR 2 at CR 100S, 4.4 miles south of US 30	NA	Porter	1	1	7	19	9	1	1	3.2	2	2	398845
US 20 at Samuelson Rd, 1.0 miles east of SR 249	Portage	Porter	0	2	5	9	7	0	2	3.1	2	2	394152
SR 56 at Lake Rd (CR 100W), 0.3 mile west of I-65	Scottsburg	Scott	0	2	4	33	6	0	4	3.93	2	4	454166
SR 44 at Progress Rd, 0.4 mile southwest of I-74	Shelbyville	Shelby	0	3	6	42	9	0	3	3.9	3	3	459748
SR 66 at Lincoln Av	Rockport	Spencer	0	2	5	25	7	0	2	3.54	2	2	466541

Table 2 continues

US 35 at CR 25 N, 1.2 miles north of Culver Rd (SR 8 south junction)	Knox	Starke	1	1	9	39	11	1	1	4.18	2	2	470221
US 52 (Sagamore Pkwy) at Kossuth St	Lafayette	Tippecanoe	1	3	15	82	19	1	3	3.32	4	4	482847
SR 38/SR 25 at Creasy Lane	Lafayette	Tippecanoe	0	3	23	63	26	0	3	6.66	3	3	464619
US 52 at Yeager Rd	West Lafayette	Tippecanoe	0	2	12	77	14	0	4	5.29	2	4	478600
US 52 at Cumberland Av	West Lafayette	Tippecanoe	0	2	17	82	19	0	2	5.17	2	2	478205
SR 26 (EB, South St) at 4th St	Lafayette	Tippecanoe	1	1	29	89	31	1	1	5.01	2	2	483138
SR 26 (EB, South St) at 9th St	Lafayette	Tippecanoe	0	2	9	57	11	0	2	4.98	2	2	485430
US 52 at CR 500W , 1.7 miles east of US 231 west junction	NA	Tippecanoe	0	2	7	63	9	0	2	4.71	2	2	481980
SR 26 (WB) at Pierce St/Andrew Place	West Lafayette	Tippecanoe	0	2	5	72	7	0	2	4.46	2	2	482261
SR 26 at Newman, 0.5 mile west of SR 526	West Lafayette	Tippecanoe	0	2	11	17	13	0	2	3.81	2	2	484359
SR 57 at Boonville-New Harmony Rd	Evansville	Vanderburgh	3	0	13	14	16	3	3	4.19	3	6	493621
SR 66 (Lloyd Expwy) at Burkhardt Rd	Evansville	Vanderburgh	0	2	18	82	20	0	2	3.1	2	2	427445
US 41 at Jessica Dr	Terre Haute	Vigo	0	3	11	49	14	0	6	3.13	3	6	504718

Table 3 Road Segments in Indiana 2007 Five-Percent Report (sorted by county)

Location	City	County	Length (miles)	No. Fatal Crashes (FTC)	No. Incapa-citating Injury Crashes (IINC)	No. Non-Incapa-citating Injury Crashes (NINC)	No. Property-Damage-Only Crashes (PDC)	No. Fatal and Injury Crashes (IFC)	No. Persons Killed (FTP)	No. Persons Seriously Injured (IINP)	Index of Crash Loss (I)	Density of Fatal and Incapa-citating Personal-Injury Crashes (DEN_ FTIINC)	Density of Persons Killed or Seriously Injured (DEN_ FTIINP)	Segment ID (SEG_ID)
I-69 from 0.3 to 0.5 mile north of US 24 north junction (Jefferson Blvd)	Fort Wayne	Allen	0.155	0	4	12	43	16	0	4	4.33	25.81	25.81	674399
I-465 within I-865 interchange	Indianapolis	Boone	0.068	1	0	12	32	13	1	1	4.32	14.71	29.41	39818
I-65 from 0.2 to 0.4 mile north of SR 60	Sellersburg	Clark	0.155	0	3	60	243	63	0	3	10.51	19.35	19.35	625007
SR 3 from 0.3 to 0.4 mile south of I-74	Greensburg	Decatur	0.055	0	1	10	35	11	0	1	4.26	18.18	18.18	102543
US 33 from 0.1 to 0.2 mile south of College Av	Goshen	Elkhart	0.115	0	2	6	16	8	0	2	3.21	17.39	17.39	626685

Table 3 continues

US 31 (Meridian St) from 0.2 to 0.3 mile north of Old Meridian St	Carmel	Hamilton	0.075	0	3	14	55	17	0	3	5.07	40	40	598325
SR 32 from 0.1 to 0.2 mile west of SR 37	Noblesville	Hamilton	0.145	0	2	10	29	12	0	3	3.23	13.79	20.69	180921
I-65 from 0.1 to 0.5 mile north of US 231 exit #205	NA	Jasper	0.428	4	1	14	25	19	4	2	3.49	11.68	14.02	690900
SR 912 (Cline Av) from 0.1 to 0.2 mile north of SR 312	Gary, East Chicago	Lake	0.058	1	1	6	29	8	1	1	3.1	34.48	34.48	274868
I-90 (Ind. Toll Rd) from 0.4 to 0.5 mile west of Lake-Porter county line	Gary, Lake Station	Lake	0.068	0	1	2	40	3	0	1	3.12	14.71	14.71	527923

Table 3 continues

US 30 from 0.3 to 0.4 mile west of Whitcomb St (1.3 to 1.4 miles west of SR 55)	Merrillville	Lake	0.145	0	2	30	144	32	0	2	7.22	13.79	13.79	554424
US 30 from 0.1 to 0.2 mile east of Austin Av (1.5 to 1.6 miles east of US 41)	Merrillville	Lake	0.145	0	2	10	24	12	0	2	3.08	13.79	13.79	472518
I-80/I-90 (Ind. Toll Rd) from Lake-Porter county line to 0.2 mile east	Portage	Porter	0.175	1	3	8	66	12	1	4	4.56	22.86	28.57	470468
US 20 from 0.1 to 0.2 mile west of Wagner Rd (2.0 to 2.1 miles east of I-94)	Porter	Porter	0.105	1	1	4	59	6	1	1	4.41	19.05	19.05	466954

Closing Remarks

The 2007 Five-Percent Report uses a methodology considerably improved when compared to the 2006 report. This year, we used the GIS methods to their full extent. A digital representation of the all public roads in Indiana has been created and processed for improved quality. For the first time, analysis in 2007 screened all intersections between state and local roads. This is a major step towards incorporating all public roads in the screening process.

Splitting segments into smaller parts allowed more specific location of sites with safety problems. Also, incorporating incapacitating injuries into the ranking process has made Indiana network screening consistent with the national emphasis on severe crashes. At the same time, the unique Indiana method based on the crash loss index allows sound statistical consideration of random fluctuation in crash occurrence.

The last important improvement is updating the Indiana average crash costs for various types of locations consistent with the screening method. This update has allowed more accurate estimation of economic losses caused by crashes at screening locations.

The current identification method is planned to be modified in coming years to screen all public roads including local segments and intersections. Data challenges with respect to sheer availability, format, and quality prevented that for the 2007 Five-Percent Report. Overcoming these challenges may be accomplished by clustering locations and substituting traffic volume data with land development characteristics where traffic volumes are missing.

As mentioned in the Introduction, multiple factors contribute to crash events, and for that reason, different countermeasures to reduce crash risk may be appropriate at different locations. For example, in some cases police enforcement is the most effective measure, while in others road engineering methods such as road geometry or traffic control improvements are most advisable, and yet at other locations a combination of these treatments work best.

Finally, while the set of 110 safety need locations produced through this system-wide effort associated with the annual Five-Percent Report to FHWA is of tremendous value to professionals charged with overseeing programs to improve traffic operating conditions on Indiana's roads, this certainly is not the sole means by which potential sites in need of safety improvements are established. Among other channels for seeking out candidate locations, INDOT, Indiana's Metropolitan Planning Organizations (MPO), local transportation agencies, and other partners—through various analytical processes—carry out crash data investigations continually through the year, generating outcomes that contribute to the overall collection of potential road safety needs.

APPENDIX A: Safety Performance Functions

A *safety performance function* is a statistical equation which calculates the typical number of severe or PD crashes at a road location based on the risk exposure at that location such as traffic volumes at intersections and traffic volume and segment length at road segments. The safety performance functions for segment types and intersections in Indiana have been developed from the road and crash data obtained with help of the Indiana GIS road network, its road and traffic attributes, and through assigning crashes to the network segments and intersections using tools developed for TransCAD. Safety performance functions have been fitted to the road and crash data with LIMDEP, a widely used statistical package. The results are presented in this appendix.

Safety performance functions for segments are in the following form (parameter values are in Tables A.1 and A.2):

$$a = \exp(k) \cdot LEN^{\alpha} \cdot AADT^{\beta}$$

where:
a = expected number of crashes in **three** years,
k = log of the slope parameter,
LEN = segment length in miles,
α = segment length parameter,
$AADT$ = Annual Average Daily Traffic in veh/day,
β = AADT parameter.

Safety performance functions for state intersections and freeway interchanges are in the following form (parameter values are in Tables A.3 and A.4):

$$a = \exp(k) \cdot AADT1^{\alpha} \cdot AADT2^{\beta}$$

where:
a = expected number of crashes in **three** years,
k = log of the slope parameter,
$AADT1$ = major road AADT in veh/day,
α = major AADT parameter,
$AADT2$ = minor road AADT in veh/day,
β = minor AADT parameter.

Safety performance functions for state-local intersections are in the following form (parameter values are in Tables A.3 and A.4):

$$a = \exp(k) \cdot AADT1^{\alpha}$$

where:
a = expected number of crashes in **three** years,

k = log of the slope parameter,
$AADT1$ = major road AADT in veh/day,
α = major AADT parameter.

Table A.1 Segment safety performance functions – injury/fatal crashes

Segment Type	Log(Slope Parameter) k	Segment Length Parameter α	AADT Parameter β	Over-dispersion D
Rural two-lane	-6.377	0.8914	0.7290	2.275
Rural multilane	-8.327	0.5155	0.8399	2.586
Urban multilane	-9.988	0.5243	1.071	2.694
Rural interstate	-8.616	0.7307	0.9136	1.984
Urban two-lane	-7.262	0.8052	0.8655	3.066
Urban freeway	-11.23	0.5785	1.163	1.503
Urban one-way	-8.468	1.000	1.019	6.373

Table A.2 Segment safety performance functions – property damage only crashes

Segment Type	Log(Slope Parameter) k	Segment Length Parameter α	AADT Parameter β	Over-dispersion D
Rural two-lane	-4.867	0.8784	0.6968	2.002
Rural multilane	-6.573	0.6486	0.8255	2.073
Urban multilane	-5.946	0.3741	0.7837	3.160
Rural interstate	-4.932	0.7846	0.7052	2.244
Urban two-lane	-5.342	0.7312	0.7631	2.893
Urban freeway	-9.228	0.4389	1.093	1.978
Urban one-way	-7.069	0.6606	0.9418	1.926

Table A.3 Intersection and interchange safety performance functions – injury/fatal crashes

Intersection/ Interchange Type	Log(Slope Parameter) k	Major AADT1 Parameter α (veh/day)	Minor AADT2 Parameter β (veh/day)	Over-dispersion D
Rural state intersection	-6.911	.5731	.3491	1.354
Rural state-local intersection	-8.013	.8206	-	4.326
Urban state intersection	-6.438	.5557	.3310	1.038
Urban state-local intersection	-9.804	1.068	-	2.422
Freeway interchange	-7.172	0.5351	0.3524	1.395

Table A.4 Intersection/interchange safety performance functions – property damage only crashes

Intersection/ Interchange Type	Log(Slope Parameter) k	Major AADT1 Parameter α (veh/day)	Minor AADT2 Parameter β (veh/day)	Over-dispersion D
Rural state intersection	-6.910	0.6519	0.4046	0.9921
Rural state-local intersection	-6.618	0.7900	-	3.320
Urban state intersection	-6.754	0.6237	0.4441	1.155
Urban state-local intersection	-8.179	1.030	-	2.143
Freeway interchange	-6.706	0.5187	0.4539	1.303